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Estimate of 1998 Recreational Halibut Catch in British Columbia Waters

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Abstract

The 1998 recreational catch of Canadian landed Pacific halibut was estimated using information from creel surveys and logbook records. The 1998 catch estimate is 38,100 pieces. This estimate should be considered a minimum estimate since it does not include any correction or expansion for non-coverage in certain months by creel survey or non-submission of logbook records in some areas. However, large portions of the catch are estimated with reliable sources of information. An attempt was made to correct for the shortcomings in coverage by creel survey and logbook programs and an expanded estimate is 44,400 pieces. The International Pacific Halibut Commission is presently using information from a 1995 angler response survey program (The National Survey) to estimate the British Columbia 1998 recreational halibut catch. We suggest that the 1998 estimate presented here is the best estimate of Canadian landings of recreationally caught halibut.

Résumé

En 1998, les captures de la pêche récréative canadienne du flétan du Pacifique ont été estimées à partir des renseignements des enquêtes sur les prises et des registres de pêche. Les captures estimées pour 1998 s'élèvent à 38 100 individus. Cette valeur est jugée être un minimum de l'estimation minimale, car elle ne comporte pas de correction ou d'ajout pour l'absence de couverture des enquêtes sur les prises au cours de certains mois ou pour celle de l'absence des registres de pêche dans certaines zones. La plus grande partie des captures est cependant estimée à partir de sources d'information fiables. Nous avons tenté d'apporter des correctifs pour les lacunes de couverture des enquêtes et des registres, ce qui a permis d'obtenir une valeur estimée de 44 400 individus. La Commission internationale du flétan du Pacifique utilise actuellement les renseignements obtenus d'une enquête auprès des pêcheurs à la ligne (Enquête nationale) en 1995, pour estimer les captures de flétan de la pêche récréative de la Colombie-Britannique de 1998. Nous sommes d'avis que l'estimation pour 1998 que nous présentons est celle qui reflète le mieux les débarquements canadiens de flétan de la pêche récréative.

Introduction

In recent years, recreational fishing in British Columbia has expanded in its contribution to total removals of Pacific halibut (*Hippoglossus stenolepis)* and in its economic importance. The increased interest in recreational fishing for, and in the catch of, halibut is largely due to the availability of navigational aids such as Global Positioning Systems that allow anglers to re-locate concentrations of these fish. This is particularly true for areas on the west coast of Vancouver Island and the Johnstone and Queen Charlotte Straits. Consequently there is an increased interest in providing recreational catch estimates for species such as halibut. Presently, recreational catch estimates for halibut are not systematically collated for all of British Columbia. For each major statistical area, annual catch estimates are provided by either creel surveys or by logbook records from fishing lodges or charter businesses. Generally, creel surveys are conducted in areas with larger populations where resident anglers contribute to the total recreational catch. These creel surveys have been conducted for a number of years and have well documented survey designs that have been approved by the Pacific Stock Assessment Review Committee. These creel surveys are used to estimate recreational catch for other species such as salmon. In statistical areas where the population is relatively small, the majority of recreational catch is from lodge visitors. For these areas, logbook catch records are adequate for estimating total recreational catch, particularly if lodges comply with requests for records. In both creel surveys and logbook databases, the identification of the catch is most likely accurate since trained interviewers or lodge employees identify the catch and catch area is easier to remember or can be allocated by landing site.

Historically, halibut recreational catch has been estimated by the International Pacific Halibut Commission (IPHC) using angler response surveys. Presently, the IPHC uses the Survey of Recreational Fishing in Canada (the National Survey), which is conducted nationwide, to estimate the British Columbia recreational halibut catch (IPHC 1999). This survey has replaced the previous angler response survey program, the Tidal Sportfishing Diary Program, which was conducted annually from 1981-1992. The National Survey is conducted every five years, with the first survey in 1990 and the last survey conducted in 1995 (DFO 1997). This means that 1998 recreational halibut catch estimates using the National Survey are based on 1995 data.

In angler response survey programs, questionnaires are mailed out to anglers randomly selected from the license holder database. Angler response surveys have been shown to overestimate catch, mostly due to a lack of response from anglers who did not catch their target species (Jones 1982; Pollock et al. 1994). Nonresponse bias can be corrected by follow-up surveys and reminders, but the 1995 estimates available from the National Survey have not been corrected for nonresponse. A comparison of angler response and creel surveys' catch estimates for coho and chinook in the Strait of Georgia, illustrated that while effort estimated by both are generally similar, the catch estimated by the angler response survey can be from 10 to 160% higher than the creel survey estimate (Appendix I). Other sources of error from angler response surveys include misidentification of species or catch area (Pollock et al. 1994). For example, in 1990 the Tidal Diary Program estimated that over 1,000 halibut were caught at the

mouth of the Fraser River (Areas 28 and 29) which is highly improbable since halibut are rare within the Strait of Georgia let alone in estuarine waters. Given that the last angler response survey was conducted in 1995, and that tidal areas of British Columbia are covered by creel surveys or logbook records, we do not use the National Survey estimates to produce a 1998 recreational halibut catch estimate.

This report collates British Columbia recreational catch estimates for halibut landed in Canada, using creel survey and logbook information. It is intended to: document, by Statistical Area, the data sources available for estimating recreational catch; provide a brief description of data collection methodology; identify any short-comings of the data sources; and collate statistical area estimates to provide a province-wide recreational catch estimate of halibut landed in Canada for 1998.

Methods

Angler Survey Methods

The sources of recreational catch information used here are from either creel surveys or logbook records. All catches are reported as pieces. Pollock et al. (1994) provided an extensive look at various methods used to survey recreational fisheries. While each survey method, whether it is an angler response survey, a creel survey or logbook records, does have weaknesses and strengths, creel surveys (access point and roving) offer the lowest potential for errors when estimating fishing areas, effort and catch (Pollock et al. 1994). When conducted in an area, we have used creel survey estimates for a statistical area.

The most well-established creel survey is the Strait of Georgia Creel Survey (SGCS) which covers fishing activity throughout the Strait of Georgia. The SGCS has been conducted every year since 1980 and has a well documented methodology (Collicutt and Shardlow, 1990). The survey is based on a stratified random sampling design with geographical area, month day type, time of day and guided versus non-guided boats comprising strata. Interview location sites are chosen based on representation, traffic volume, accessibility and adequate observation points. The interview locations cover all types of recreational fishing activity, including anglers landing with halibut catches. Aerial overflights are conducted several times per month. The flight routes and times are predetermined to cover major concentrations of recreational fishing activity with avoidance of times during which fishing effort rapidly changes. The flight routes cover major areas of halibut fishing activity. Days are randomly selected to cover each day type. The methods and equations (including weighting factors and estimation procedures) used to estimate catch statistics from stratified interview data are provided in Appendix II.

Creel surveys are conducted in other statistical areas with high recreational fishing activity, such as north Queen Charlotte Islands, Nass and Skeena, Johnstone Strait and Barkley Sound. These creel surveys are modelled after the survey design of the SGCS and entail aerial or boat surveys of active fishing boats, interviews at landing sites and, in some cases, roving interviews.

All surveys stratify the survey area and sampling times using the SGCS design and analyse interview and flight information using the same weighting factors and equations.

In some areas, creel surveys are not conducted, mainly because there is no resident population and virtually all the fishing activity is from visitors to isolated lodges. Lodges and charter businesses are requested to fill in logbooks recording total catch for each fishing trip. These logbooks are submitted to Fisheries and Oceans Canada under the Logbook Survey Program. Pollock et al. (1994) suggest that logbook records are trustworthy methods for surveying anglers when there is co-operation and a high response rate. In some areas where the few lodges and charters business make up most of the recreational fishing activity, logbook response has been approximately 95-100%. An example of a logbook form is provided in Appendix III. Information available from logbooks include date, area fished, effort (hours fishing), number of anglers, total catch in pieces (kept and released). While there are limitations to the use of logbooks in fisheries management, when response is high, logbook records can provide reliable information on catch and effort (Pollock et al. 1994). In areas with no creel survey, the response rates for logbook submission are high. We therefore have used total catch reported in lodge and charter business logbooks to estimate recreational halibut catch in those areas.

Data Sources

For the purpose of catch reporting the coast of British Columbia is divided into 29 major Statistical Areas (Figure 1). There are only a few areas that historically have had recreational halibut catch greater than 1000 pieces: Area 1 (Dixon Entrance north Queen Charlotte Islands), Area 2 (Queen Charlotte Islands), Area 3 (Nass River), Area 4 (Skeena River), Area 12 (Johnstone Strait), Area 19 (Victoria), Area 20 (Juan de Fuca Strait) and Area 23 (Barkley Sound). Table 1 outlines the data sources for each statistical area.

Queen Charlotte Islands

Areas 1 and 2 – All angler (resident and visitor) catches, were estimated by the Haida Gwaii Creel Survey. In 1998, active fishing boats were estimated by boat surveys and a total of 1946 interviews were conducted at 8 landing sites from June through mid-September. These survey dates cover the ocean fishing season around the Queen Charlotte Islands. The methodology for this creel survey is outlined in Searing and Bocking (1996).

Unfortunately, there was uneven survey coverage for September 1998 with one subarea not covered (1B). The average June-August effort ratio between 1B and an adjacent subarea, 1C, was used to estimate the September effort in 1B from the effort estimated for 1C. The average June-August catch per unit effort for subarea 1B was used to expand this estimated effort to September catch in subarea 1B.

The Haida Gwaii Creel Survey covers the portions of Area 2 that have recreational fishing activity (west coast Queen Charlotte Islands and Skidgate Channel). Portions not covered by

the creel survey do not have large populations, or have little fishing activity (e.g. Skidgate Inlet), or do not have lodges in that area. Therefore, the creel survey coverage is likely adequate for Area 2.

North Coast

Areas 3 and 4 -- These areas are surveyed by the Area 3 and 4 Sport Fish Creel Survey program. In 1998, the survey was conducted from July through September. A total of 962 interviews were conducted at 4 landing sites and 23 overflights were used to survey active fishing boats. Surveys in 1995 and 1996 covered mid-May through September. We used the average proportion of mid-May and June estimated catches to the July through September estimated catches in order to estimate the missing months in 1998.

Area 5 – No estimates of recreational halibut catch were available for Area 5. Area 5 comprises northern Hecate Strait from the southern end of Banks Island to the southern end of Porcher Island. There are no lodges in the area and very likely to be little, if any, catch (i.e. <<100) by independent anglers since the area is so remote from any centre of population. In order to provide a 'ceiling' estimate, we referred to previous Record Management Strategy documents (RMS) for this area. Each year a RMS is submitted by Local Fisheries Guardians or Officers to District Offices. These documents are available from District Offices or from Regional Offices (e.g. South Coast Division, 3225 Stephenson Point Road, Nanaimo, British Columbia, V9T 1K3) of Fisheries and Oceans Canada, Pacific Region, Operations Branch. The RMS documents describe the work done each year including any survey work or catch monitoring. The estimates of recreational catch are not derived from standard creel surveys, but they do represent estimates from experienced personnel closest to the resource. We have used estimates provided in recent years as an indicator of the likely highest catch of halibut. We have arbitrarily assigned an estimate of 100 halibut for Area 5.

Central Coast

Areas 6-9 – There are 6 lodges and charter businesses operating in Area 6; 4 lodges operating in Area 7; 8 lodges and charter businesses operating in Area 8; and 11 lodges in Area 9. Most of the recreational halibut catch is taken by lodge clients and charter users, with all catch recorded in logbooks. In 1998, all lodges and charter businesses in the areas submitted logbooks.

Areas 10-11 – No estimates were available for recreational halibut catch for Areas 10 or 11. There are no lodges or population centres in these remote areas which are located in southern Queen Charlotte Sound. As for Area 5, we have assigned a catch of 100 halibut to each of these areas based on information in previous RMS documents. Some recreational fishing may take place in the extreme southern portion of Area 11 by fishers coming from Area 12. Their catch will be reported as coming from Area 12.

Johnstone and Queen Charlotte Straits

Area 12 – The North Vancouver Island Creel Survey has been conducted sporadically since 1991. Methodologies and survey design are outlined in Collicutt et al. (1992). The survey covers access point anglers, and lodge visitors with lodge logbooks. In 1998, 1,622 interviews were conducted at 6 landing sites and 22 flyovers were used to estimate fishing activity. The survey was conducted from July through September. Only three businesses submitted logbooks for July, August and September of 1998. We used the average number of trips and the average number of halibut caught per trip to estimate the catch of all lodge and charter users (48 businesses). Since the creel and logbook records did not cover the early fishing season (April through June), we used the monthly catch profile (April through August) in Collicutt et al. (1994) for the 1993 survey to estimate the relative proportion of the catch for April, May and June to that of July and August. The catch in Collicutt et al. (1994) was an estimate of independent and lodge/charter business users.

South Coast

Areas 13-19, 28-29 – The recreational catch in the Strait of Georgia is extensively surveyed by the Strait of Georgia Creel Survey. In 1998, the survey was conducted from April through September for all areas and through October for Area 19 when recreational halibut fishing ends. A total of 12,736 interviews were conducted at 147 landing sites throughout the season, with an additional 183 interviews at 5 landing sites conducted in Area 19 in October. In total, there were 63 flyovers for aerial estimates of active fishing boats. Area 19 (Victoria-Juan de Fuca Strait) and part of Area 20 is the only area covered by the Strait of Georgia Creel Survey that has had a substantial annual recreational halibut catch (>100). The only other areas with any recreational halibut catch have been Areas 13, 14, 15 (Northern Strait of Georgia) but the estimated catches are below 100. Recreational catch of halibut in these areas is usually May through August with very little (if any) catch extending into the fall. So the creel survey does cover the majority of recreational halibut fishing season in the Strait of Georgia.

Area 20 – The portion of Area 20 (Juan de Fuca Strait), where most recreational fishing takes place (Race Rocks to Sheringham Point) is covered by the Strait of Georgia Creel Survey. This portion is reported in the catch estimate for Area 19. Another portion of Area 20 where halibut fishing takes place is landed at Port Renfrew. A creel survey was conducted in Port Renfrew by the Pacheedaht First Nation from May through September. A total of 1,927 interviews were conducted at 3 landings sites with 41 surveys of active fishing boats.

West Coast Vancouver Island

Areas 21 and 22 – There were no sources of estimates of recreational halibut catch for Areas 21 or 22 (Nitinat Lake). However, a 1993 creel survey for these areas estimated a recreational

halibut catch of zero and given the location and the small size of these statistical areas it is not likely critical that no estimate is provided for 1998.

Areas 23 and 24 – Area 23 was surveyed by the Barkley Sound/Alberni Inlet Creel Survey, that has been conducted annually since 1989. Though not formally published, the survey design is outlined in a 1989 report (DFO, 1989). In 1998, the creel survey was conducted from June 15 through September 15, and covers both non-guided and guided anglers. A total of 7,285 interviews were conducted at 8 landing sites with 62 aerial surveys of active fishing boats. A lodge operates in Area 23 and is not covered by the creel survey. However, logbook records for each fishing month were submitted to Fisheries and Oceans Canada.

Area 24 is surveyed by the Clayoquot Sound Creel Survey which was conducted from June 15 through September 15 with a total of 936 interviews at 1 landing site and 26 aerial surveys of active fishing boats. This survey covers non-guided angler catch only. Approximately five guide businesses operate in Area 24, with only one large business targeting halibut. The catch recorded in this business' logbook was used as the guided catch for this area. For confidentiality, we combine their reported halibut catch with the reported halibut catch from the lodge in Area 23.

Some charter business owners were canvassed by phone in order to assess when the halibut fishing began. In 1998, the majority of operators began fishing activities at the end of May or suggested that the halibut catch in May is negligible. We doubled the June or September creel survey estimates to reflect the whole, rather than half, month.

Area 25 – This area historically has had small recreational groundfish catch. Previous estimates from RMS documents have been less than 500. We allotted 500 pieces as the 1998 halibut catch estimate in Area 25.

Area 26 – For Area 26 (Kyuquot Sound), previous catch estimates made in RMS documents have been less than 100 pieces. We allotted 100 pieces as the 1998 halibut catch estimate in Area 26.

Area 27 – There was no method of estimating the 1998 recreational halibut catch in Area 27 (Quatsino Sound). Recreational fishing activity is quite low in the area, and previous estimates of halibut catch reported in RMS documents range from 0 to 100.

Estimate of Average Weight

Unfortunately, weights are not collected by creel or logbook programs for recreational catches in British Columbia. The only source of weights that we found available for recreationally caught halibut in 1998 was from a lodge located at Langara Island in Area 1. As part of their daily catch ritual, halibut are weighed whole upon return and recorded as pounds (lbs). We report the mean landed weight for these halibut.

Results

Separate catch estimates for statistical area are reported in Table 2. For each statistical area, the minimum catch estimate represents the original estimate supplied by creel programs or logbook programs. As such, these catch estimates should be considered minimum estimates. The total minimum estimate for 1998, rounded to the nearest 100, is 38,100 pieces. Estimates of error were available from only two creel survey programs. The Johnstone Strait Creel Survey estimated 3,652 (S.E. = 405) halibut were caught from July through September. The Strait of Georgia Creel Survey estimated 2,203 (S.E.=446) pieces of halibut caught from April through October.

Expanded estimates

The expanded catch represent the original estimates expanded within this study to try to account for: catch during times when creel surveys are not conducted (e.g. half of a month or early season); catch by businesses that did not submit logbooks; or catch in areas without any creel or logbook programs (Table 2).

Areas 1 and 2 – The June-August effort ratio between sub-area 1B and adjacent sub-area 1C was 0.26. The total effort in September for 1c was 614 angler days and the average catch per unit effort for 1B (June-August) was 0.99 halibut per angler day. The estimated catch for 1B was 146 pieces.

Areas 3 and 4 -- The average proportion of catch in Many and June of 1995 and 1996 was 45 % of the catch in July-September. The estimated catch for mid-May through June (1998) was 1,224 in Area 3 and 553 in Area 4.

Area 12 – Only three businesses submitted logbooks for Area 12 in 1998. There are 48 lodges and charter businesses operating in the area. The mean number of trips per business in July, August and September were 9.33, 12.5 and 7 respectively. The mean number of halibut caught per trip in July, August and September were 0.98, 1.36 and 0.14 respectively. The expanded catch estimate for lodge and charter businesses is 1,295 pieces.

The monthly catch profile of the 1993 creel survey in Area 12 (Collicutt et al. 1994), estimated zero catches of halibut for both independent and guided anglers in April and May. We therefore assumed that the catch of halibut in April and May in Area 12 in 1998 was negligible and can be estimated as zero. The June catch in 1993 was 26.26 % of the combined July and August catch, so we estimated the June 1998 catch to be 1,206 (26.26% of 4,947 total pieces for July and August).

Areas 23 and 24 – The catches estimated by creel survey in Area 23 for the last half of June and the first half of September were 849 and 18 pieces respectively. In Area 24, 49 halibut

were estimated to have been caught in the last half of June and 6 halibut for the first half of September. These numbers were used as catch estimates for the half of each month not covered by the creel surveys in each Area.

The total expanded estimated recreational halibut catch landed in Canadian waters for British Columbia for 1998, rounded to the nearest 100, is 44,400 (Table 2). Regionally, the Queen Charlotte Islands and the West Coast of Vancouver Island had the highest recreational halibut catches and the Central Coast had the lowest (Figure 2).

Mean weight

The mean undressed weight for halibut caught in an Area 1 lodge was 18.9 lbs, or 8.57 kg. Standard deviations for this mean are not available because weights and numbers were recorded as cumulative. In other years, the mean weight (round) from another lodge in the eastern portion of Area 1 (Naden Harbour) were as follows: 1989 - 20.5 lbs; 1990 - 21.8 lbs; 1991 - 23.8 lbs; and 1992 - 22.8 pounds. The mean weight across all years is 21.6 (stdev=1.73).

Discussion

While the methods of estimating recreational halibut catch throughout British Columbia are admittedly varied, the methods available for each area are generally best suited to that area's recreational fishing activity. In areas dominated by lodge activity, logbook records were submitted by each lodge. Non-submission may be a factor that detracts from the records' usefulness in other areas, but for the more remote areas in which we used logbook records, all logbooks were submitted in 1998. The creel surveys that combine access-point interviews with roving interviews and aerial or boat surveys of active fishing boats are considered the most reliable methods of estimating recreational catch (Pollock et al. 1994). These two sources of data were available for the areas that contributed highly to the total British Columbia catch. The only alternate source of estimating recreational halibut catch is the National Survey, which for reasons discussed earlier is not a practical alternate source. The 1995 recreational halibut catch estimate by the National Survey was 97,771 pieces which is likely an overestimate of the true halibut recreational harvest (IPHC 1999).

Of the 29 Statistical Areas, 8 areas had no 1998 data sources for estimating recreational halibut catch. However, one of these areas is dominated by freshwater (Area 22, Nitinat Lake) and another is very small in area (Area 21). Five of the areas with no data sources historically have not had recreational halibut catch estimates greater than 100 (Areas 5, 10, 11, 26 and 27). Here we have assigned 100 pieces to each area. The remaining area with no data sources (Area 25) was allotted 500 pieces based on historical estimates. Though allotting 1,000 pieces to these areas is arbitrary, it is only 2.3 % of the total expanded catch that was estimated for all other areas. Though it would be preferable to have sources of data for every area, the absence of data sources in these areas is not likely critical to the overall British Columbia catch estimate.

In each case we have used the high range observed historically, so we have not likely underestimated the catch in these areas.

Another source of error for some of these data sources is the lack of creel survey coverage in early months for some areas (Areas 12, 20, 23, 24, 25 and 26) and for fall and winter months for all areas. The only Areas that have some fall coverage are Areas 19 and 20. These Areas are covered by the Strait of Georgia Creel Survey program that extends through October. We have tried to address the lack of early month coverage by using monthly catch and effort profiles available from historical creel estimates. These profiles are generally available from the first year that the survey was conducted and was used to select the months of high recreational fishing activity. Early spring, fall and winter months are not now generally covered since catch is low and the focus of the creel surveys is for salmon fishing.

The only source of weight estimates was the single lodge in Area 1. Since the average weight of recreational caught halibut will likely vary from the northern to the southern regions of British Columbia, we have not used this weight to express the estimated catch in pieces as an estimated catch in pounds or kilograms. The IPHC (1999) reported mean weights (1990-1997) of halibut caught in the recreational fishery in an adjacent Alaskan area and in the Neah Bay recreational fishery (which is adjacent to southern British Columbia). In five of the eight years, the average weights of halibut caught in Alaska were on average 1.5 times higher than those caught off Washington State. In the remaining years, the weights in Alaska were on average 0.8 times lower. This suggests that the average weight of halibut caught in northern British Columbia will be approximately equal to 1.5 times higher than halibut caught in southern areas. We do not have any information on size differences for recreational halibut catch throughout the province to adjust the weight for specific Statistical Areas. In addition, the mean weight in 1998 from Area 1 is lower than mean weights reported in previous years. However, it is within the range of mean weights for the Alaskan recreational fishery (IPHC 1999).

We suggest that the 1998 recreational catch of halibut was approximately 38,100 pieces. This represents a minimum estimate and attempts to account for low coverage in early months or low rates of logbook submission expanded this estimate to 44,400 pieces. It is important to note that this catch estimate is for Canadian landings only. It does not include any halibut removed from Swiftsure Bank by anglers from Washington State that are landed at Neah Bay, Washington. A creel survey program operated by the Washington State Department of Fish and Wildlife estimate the halibut catch at Swiftsure Bank to be 10,371 pieces (R. Geist, pers. comm., Washington State Department of Fish and Wildlife). The Canadian landings estimate reported in this paper also does not include any catch taken by American guided boats operating within Canadian waters. Some American-owned guide businesses may fly customers in from the United States and many not necessarily land their catch at landing sites covered by creel surveys. They also do not submit logbook records to Canadian or American agencies. This may only be important for non-halibut catch, such as chinook and coho which are likely high, and may only occur in southern areas such as Barkley and Nootka Sounds.

Unfortunately, there are no confidence intervals for the estimate reported here, since some creel survey programs do not provide standard error estimated for catch or effort. Improvement to the reporting of the recreational catch estimate would be the calculation of standard error for all creel catch and effort estimates. Estimates from logbook records also do not have estimates of error. Random checks on lodge catches could be used to assess the accuracy of logbook reporting in the areas where we have used them. These suggestions would improve the reporting of the recreational catch. Improvement in the accuracy of catch estimates could result from: increased submission rates for logbook records in Area 12; earlier coverage of creel surveys for months in which non-salmon species, such as halibut, are targeted by anglers (e.g. April – June); and biological measurements, such as weight, incorporated into creel surveys or logbook records.

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Table 1. Sources of recreational halibut catch by major statistical area in British Columbia tidal waters.

Area	Source	Area	Source
1	Haida Gwaii Creel Survey	16	Strait of Georgia Creel Survey
2	Haida Gwaii Creel Survey (2W)	17	Strait of Georgia Creel Survey
3	Area 3 & 4 Sport Fish Creel Survey	18	Strait of Georgia Creel Survey
4	Area 3 & 4 Sport Fish Creel Survey	19	Strait of Georgia Creel Survey
5	No data	20	Pacheedaht Creel Survey
6	Lodge Logbooks	21	No data
7	Lodge Logbooks	22	No data
8	Lodge Logbooks	23	Barkley Sound Creel Survey Lodge Logbook
9	Lodge Logbooks	24	Clayoquot Sound Creel Survey Logbook record
10	No data	25	No data
11	No data	26	No data
12	North Island Creel Survey	27	No data
13	Strait of Georgia Creel Survey	28	Strait of Georgia Creel Survey
14	Strait of Georgia Creel Survey	29	Strait of Georgia Creel Survey
15	Strait of Georgia Creel Survey		

Table 2: The 1998 recreational halibut catch estimates by major statistical area. Zeros denote actual estimates and blank cells denote no data available for estimates. The estimates are produced from creel surveys (C), logbook records (L) or are allotted catch (A) based on Regional Management Strategies. The minimum estimate represents the uncorrected estimate provided by each source. The expanded estimate represents the original catch estimate expanded to account for months not covered by creel surveys, low rates of logbook submission.

Area	Source	Minimum Estimate	Expanded Estimate	Area	Source	Minimum Estimate	Expanded Estimate
1	C	7,765	7,911	16	C	0	0
2	C	680	680	17	C	0	0
3	C	3,000	4,224	18	C	0	0
4	C	1,354	1,907	19	C	2,131	2,131
5	A		100	20	C	1,385	1,385
6	L	380	380	21	A		0
7	L	435	435	22	A		0
8	L	877	877	23	C	9,040	9,907
9	L	260	260	24	C	337	392
10	A		100	23/24	L	6,660[1]	6,660[1]
11	A		100	25	A		500
12	C L	3,652 61	4,531 1,622	26	A		100
13	C	46	46	27	A		100
14	C	13	13	28	C	0	0
15	C	13	13	29	C	0	0
				Total		38,089	44,374

[1]For confidentiality, lodge catch estimates for Areas 23 and 24 are presented as a combined total.

Figure 1. Major statistical areas of a) Northern and b) Southern British Columbia

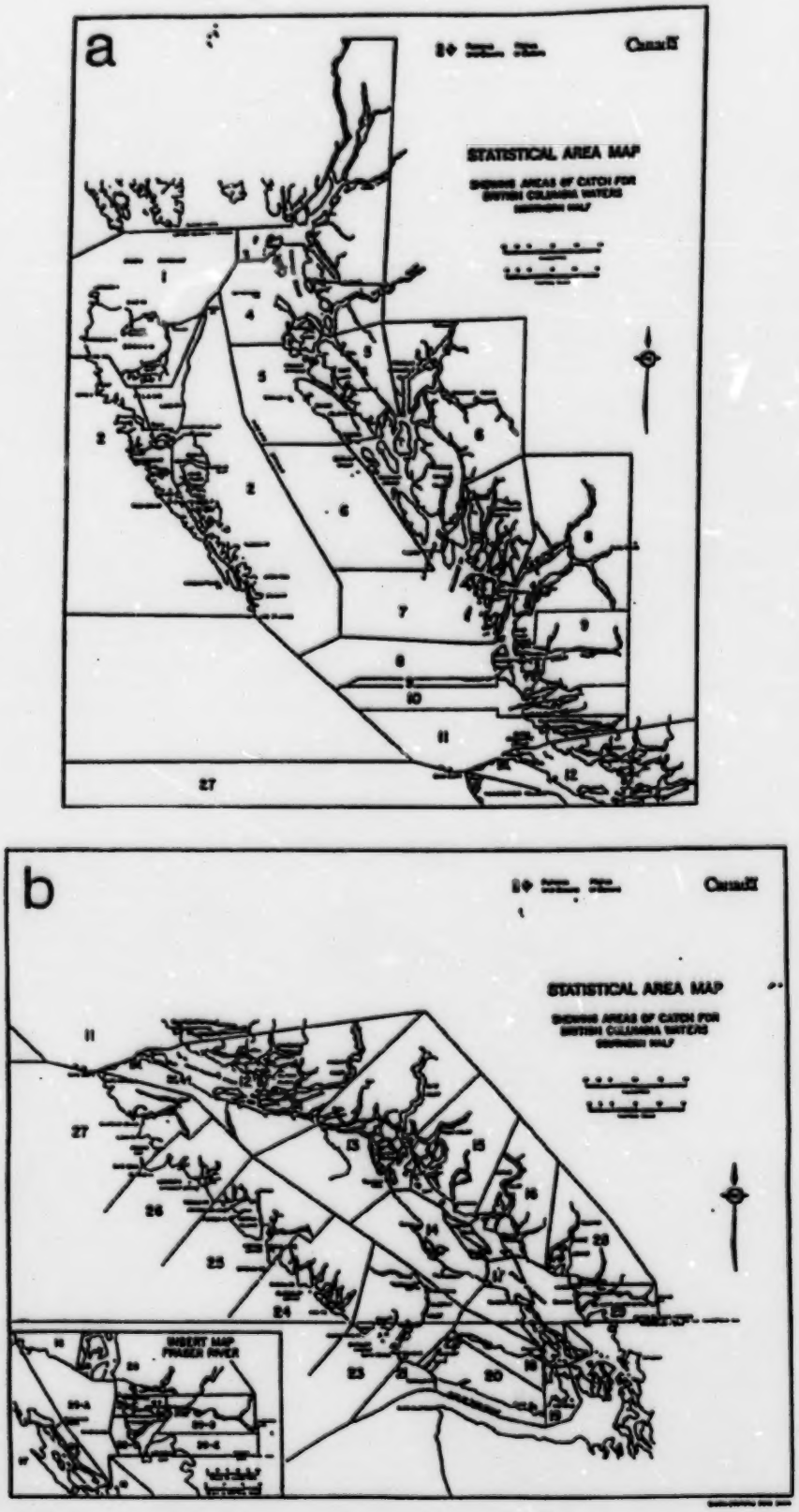
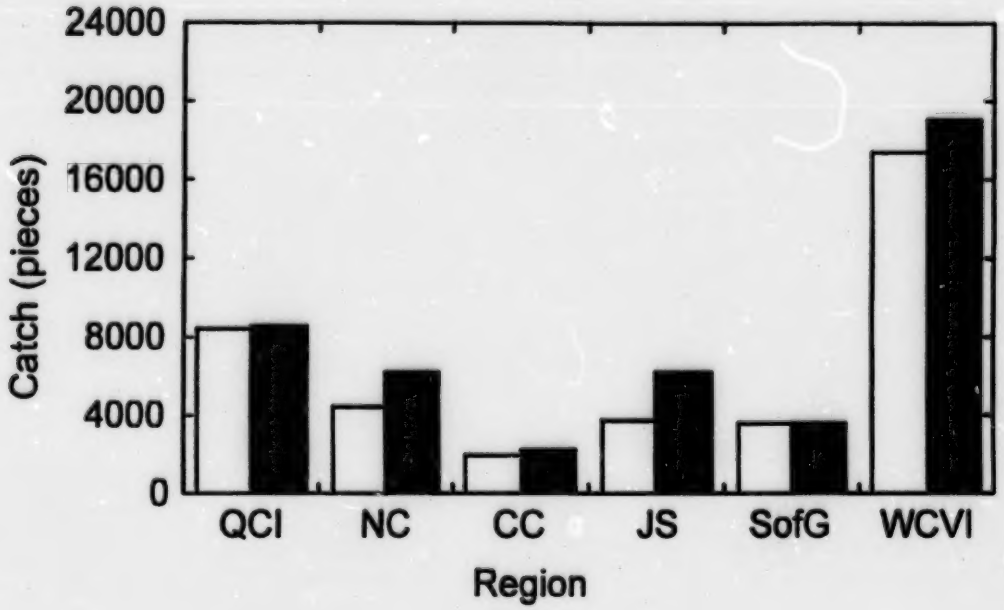


Figure 2. The minimum (open bars) and expanded (solid bars) 1998 recreational catch of halibut for Queen Charlotte Islands (QCI), North Coast (NC), Central Coast (CC), Johnstone Strait (JS), Strait of Georgia including Juan de Fuca Strait (SofG) and the West Coast of Vancouver Island (WCVI).



Appendix I

Estimates (thousands of pieces) of recreational coho and chinook catch in the Strait of Georgia from annual summaries of the Tidal Diary and Visitor Survey and Strait of Georgia Creel Surveys (T. Gjernes, unpublished data, Operations Branch, South Coast Division, Nanaimo, BC, V9R 5K6.)

	Coho			Chinook		
Year	Diary	Creel	Ratio D/C	Diary	Creel	Ratio D/C
1987	713.4	579	1.2	196.3	88	2.2
1988	1077.7	1003	1.1	119.8	83.1	1.4
1989	701.8	407.5	1.8	240.8	97.7	2.5
1990	684	559.6	1.2	142.6	79	1.8
1991	116.3	45.6	2.6	n/a	40.2	

Appendix II

Methods and equations used in analysis of catch and effort statistics for the Strait of Georgia Sport Fishery Creel Survey.

The description of terms, variables and subscripts used in the data analysis is given in Table A-1.

Calculation of Catch and Effort Statistics

To estimate the monthly catch and effort, three components had to be calculated from a month's data:

(1) the weighted mean daily fishing pattern from interview data,
(2) the weighted mean catch per unit effort from interview data and
(3) the mean sport count from overflight data.

The equations used to estimate the means and variances for all catch and effort statistics are shown below.

Weighting factors used to estimate the daily fishing activity pattern and mean catch per unit effort were calculated using the equations derived from DPA Consulting Ltd. (1982).

The data obtained from each shift were multiplied by the following weighting factor (W1) to expand for all possible stints at each site. The formula reads:

$$W1_{dij} = \frac{N_d}{n_{dij}} \qquad (1)$$

where N_d is the total number of days of type d in that month and n_{dij} is the number of times the jth work block at the ith site was sampled on type d days.

The interviews aggregated by work block were multiplied by the weighting factor W2 to expand for all boats that landed in each work block. The formula reads:

$$W2_{dijk} = \frac{L_{dijk}}{l_{dijk}} \qquad (2)$$

Table A-1. Description of terms, variables and subscripts used in this report.

DESCRIPTION OF TERMS

Shift/Stint	-	Represents a combination of a day type and landing site which was sampled on a single day. I.e. one sampling stint performed by an interviewer.
Work block	-	Represents one of four possible periods at a particular site of a given day type. Work Block 1 is before 11 am Work Block 2 is 11 am - 3 pm Work Block 3 is 3 pm - 7 pm Work Block 4 is after 7 pm
Day type	-	There are two possible day types: weekdays and weekends; holidays are considered to be weekend days.
Time block	-	Each day is divided into 16 time blocks which are: 1) before 7 am 2) 7:00 - 7:29 am 3) 8:00 - 8:59 am . . . 15) 8:00 - 8:59 pm 16) after 9 pm

DESCRIPTION OF VARIABLES

A	-	Number of boats actively fishing
B	-	Number of boats observed on a flight
C	-	Catch
CPE	-	Catch per boat trip
E	-	Effort (estimated total number of boat trips)
I	-	Number of boats interviewed and found to have been fishing
L	-	Number of boats landing
n	-	Number sampled
N	-	Population size from which n samples were observed
P	-	Proportion
T	-	Number of boat trips
V	-	Number found to be marked
W1	-	Weighting factor to expand for all possible stints at each site
W2	-	Weighting factor to expand for all boats that landed in each work

DESCRIPTION OF SUBSCRIPTS

g	-	a set of landing sites
d	-	day type
i	-	site
j	-	work block
k	-	stint
l	-	landing time block
q	-	the next boat landing at site i and upon interviewing, found to have been fishing (q ranges from 1 to n)
r	-	species
s	-	sub-Statistical Area
t	-	time block
u	-	flight

where L_{dijk} is the number of boats landed and I_{dijk} is the number of boats interviewed on the kth stint in the jth work block at the ith site on a day type d.

Therefore, the following equations can be used to calculate an unbiased estimate of the total monthly catch ($\hat{C}_{dgr}$), fishing trips ($\hat{T}_{dg}$) and fishing activity in time block $\hat{A}_{dgt}$ for each day type (d) where g is a set of landing sites (i). These formulas read:

$$\hat{C}_{dgr} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk} C_{dijkqr}) \right] \quad (3)$$

$$\hat{T}_{dg} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk}) \right] \quad (4)$$

$$\hat{A}_{dgt} = \sum_i \sum_j \left[W1_{dij} \sum_k \sum_q (W2_{dijk} A_{dijkqt}) \right] \quad (5)$$

where C_{dijkqr} is the catch of species r by the qth fishing party, and A_{dijkqt} can equal 0 or 1, thereby indicating whether the qth fishing party was actively fishing in time block t. Thus, the mean monthly catch per unit effort (CPE_{dgr}) measured in terms of numbers of fish kept per completed boat trip, and proportion of daily fishing effort active during the hour of the aerial survey (P_{dgt}) can be calculated with the following equations:

$$CPE_{dgr} = \frac{\hat{C}_{dgr}}{\hat{T}_{dg}} \quad (6)$$

$$P_{dgt} = \frac{\hat{A}_{dgt}}{\hat{T}_{dg}} \quad (7)$$

where CPE_{dgr} and P_{dgt} are calculated for each day type (d) and group of landing sites (g).

The groups of landing sites reflect geographic areas with similar catch rates and/or activity patterns.

The estimated mean number of boats fishing during the hour of the sport boat count by overflight was calculated for each sub-Statistical Area using the following equation:

$$\overline{B}_{dst} = \frac{\sum_{u} B_{sdtu}}{n_{ds}} \qquad (8)$$

where B_{dstu} is the number of boats observed fishing on flight u at time t, in sub-Statistical Area s for day type d.

The mean sport boat count at the time of the overflight ($\overline{B}_{dst}$) and proportion of daily fishing effort active during the hour of the overflight (P_{dgt}) were used in the following equation to calculate the total fishing effort for sub-Statistical Area s on day type d:

$$E_{ds} = \overline{B}_{dst} \frac{1}{P_{dgt}} N_d \qquad (9)$$

where N_d is the number of type d days in the month. Interview data for the sub-Statistical Areas fished (s) by anglers landing at each of the sites (l) within a landing group (g) were used to select the proportions (P_{dgt}) that are appropriate for each mean boat count ($\overline{B}_{dst}$).

The estimate for total effort by sub-Statistical Area and day type (E_{ds}) and the weighted catch per boat trip for a group of landing sites by day type, area and species (CPE_{dgr}) were used to calculate total catch for each species (r) and each sub-Statistical Area (s):

$$C_{sr} = \sum_{d} (E_{ds} CPE_{dgr}) \qquad (10)$$

The interview data were also used to select the catch per effort estimates (CPE_{dgr}) that should be applied to the effort estimates (E_{ds}) for a specific sub-Statistical Area (s).

Variance of Total Fishing Effort

The variance for estimates of total fishing effort has two components:

(1) the variance in aerial sport boat counts:

$$S^2_{B_{dst}} = \frac{\sum_u B^2_{dstu} - \frac{\left(\sum_u B_{dstu}\right)^2}{n_{ds}}}{n_{ds}(n_{ds}-1)} \left[\frac{N_d - N_{ds}}{N_d - 1}\right] \qquad (11)$$

where B_{dstu} is the aerial sport boat count at time t during an aerial survey u on a type d day in sub-area s; n_{ds} is the number of aerial surveys in which boats were counted on type d days, in sub-Statistical Area s; and N_d is the total number of type d days in the months.

(2) the variance in the proportion of boats fishing during the hours of the aerial boat counts:

$$S^2_{P_{dgt}} = \frac{P_{dgt}(1-P_{dgt})}{I_{dg}} \qquad (12)$$

where P_{dgt} is the mean proportion of boats fishing for a group of landing sites g during the hour of the aerial boat count t on type d days, and I_{dg} is the total number of sport fishing boats interviewed. The above formula assumes P_{dgt} is unbiased and normally distributed where the number of interviews is large.

The variances for boat counts ($S^2_{B_{dst}}$) and proportion of boats fishing ($S^2_{P_{dgt}}$) were combined in the following equation to calculate variance for effort:

$$S^2_{E_{ds}} = N^2_d \left(\frac{B^2_{dst}}{P^2_{dgt}}\right)\left(\frac{S^2_{B_{dst}}}{B^2_{dst}} + \frac{S^2_{P_{dgt}}}{P^2_{dgt}}\right) \qquad (13)$$

where $S^2_{E_{ds}}$ is the variance for total effort on type d days in sub-area s, and the formula is the standard formula for the variance of a ratio of two independent random variables.

Variance of Total Catch

The variance for estimates of total catch had two components: (1) the variance for total effort (presented above), and (2) the variance for catch per boat trip.

The variance for catch per boat trip ($S^2_{CPE_{dgt}}$) was calculated using the following equation:

$$S^2_{CPE_{dgr}} = \frac{SS_{CPE_{dgr}} - \frac{(S_{CPEdgr})^2}{I_{dg}}}{I_{dg}(I_{dg}-1)} \qquad (14)$$

where $SS_{CPE_{dgr}}$ is the weighted sum of squares for CPE_{dgr}, and $S_{CPE_{dgr}}$ is the weighted sum for CPE_{dgr}, such that the sum of the weighting factors used to estimate CPE_{dgr} was equal to the number of interviewed boat trips (I_{dg}).

The variance for total effort and the variance in the catch per boat trip for the appropriately grouped landing sites were combined in the following equation to calculate variance for total catch:

$$S^2_{Csr} = \sum_{d} \left(E^2_{ds} S^2_{CPE_{dgr}} + CPE^2_{dgr} S^2_{E_{ds}} + S^2_{CPE_{dgr}} S^2_{E_{ds}} \right) \qquad (15)$$

which is the standard formula for the variance of the product of two independent random variables, and where $S^2_{C_{sr}}$ is the variance for total number of species r in sub-Statistical Area s.

Appendix III

An example of a logbook record that lodges and charter businesses are requested to fill out.

Business Name: _____ Operators Signature: _____

Vessel Name: _____ Year: _____ Logbook #: _____

Date mm/dd	Daily Trip #	Total No Fished (ave)	Total Time On Water (hrs)	Fishing Location Name	Stat-Sub Area	Anglers	Coho Kept										Released			
							Sock	Coho Mat	Coho Unmk	Pink	Chum	Chk Mat	Chk Unmk	Halib	Lingcd	Rockf	Coho Legal	Coho Sublegl	Chk Legal	Chk Sublegl

Note: "marked / unmarked" chinook and coho - See instructions inside front cover

Comment on weather, fish distribution, fish condition:

please record total shellfish taken for this period:

Note: The above sport catch information is requested pursuant to Section 61 of the Fisheries Act and is considered to be strictly confidential.

white copy - DFO yellow copy- operator